Analysis of Scale Separation Procedures

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LONG-TERM GOAL

Improving the parameterization of subgrid-scale motions in oceanic general circulation models.

SCIENTIFIC OBJECTIVES

Establish the fraction of subgrid-scale motions that is caused by propagating remotely forced waves, especially wind forced Rossby waves. Standard parameterization schemes (eddy diffusion, eddy induces transport velocities) assume that the subgrid scale fluxes are determined by local mean flow quantities. For propagating remotely forced waves this assumption becomes inadequate and non-local and perhaps stochastic parameterization schemes need to be developed.

APPROACH

Theoretical analysis and numerical calculation of the oceanic Rossby wave response to wind forcing and comparison with observations. The theoretical analysis is based on the linear quasi-geostrophic potential vorticity equation with idealized geometry and forcing. The numerical calculations use a 1-1/2 layer reduced gravity model. Observations are drawn primarily from BEMPEX (Barotropic Electro-magnetic and Pressure Experiment) and TOPEX/POSEIDON.

WORK COMPLETED

Two tasks were completed.

1. We analyzed theoretically the information content of coherence maps. These maps are an analytical tool first introduced by Brink (1989). They display the coherence between the oceanic current (or pressure) at a point (the mooring location) and the windstress carl field at other locations as a function of separation for a specific frequency band. We calculated such

coherence maps for a simple linear quasi-geostrophic model forced by statistically stationary and homogeneous wind fields.

2. We calculated the baroclinic forced and free Rossby wave response in a 1-½ layer reduced gravity model of the North Pacific and rationalized the results in terms of simple analytic models.

RESULTS

Coherence maps can be used to estimate the Green's function of the linear quasi-geostrophic potential vorticity equation by multiple regression analysis. The presence of noise or non-linearities can be inferred from the multiple coherence, which is a number. The results can be generalized to other systems where response and forcing are related by a Green's function. Comparison of calculated coherence maps with observed maps confirms the notion, derived earlier, that part of the barotropic sub-inertial variability in the ocean is directly forced by the atmospheric windstress.

The calculations with the 1-½ layer reduced gravity model show that the interplay of wind-forced Rossby waves and free Rossby waves originating at the coastal and topographic boundaries leads to apparent phase speeds between one and two times the free Rossby wave speed. The details depend on dissipation and latitude. Overall, the findings are consistent with TOPEX/POSEIDON observations (Chelton and Schlax, 1996).

IMPACT/APPLICATION

Remotely forced propagating Rossby waves constitute part of the oceanic subgrid-scale variability. The parameterization of these radiative subgrid-scale motions must be expected to require non-local and perhaps stochastic parameterization schemes.

TRANSITIONS

None

RELATED PROJECTS

None

REFERENCES

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PATENTS

None